INTERACTIONS BETWEEN APIS MELLIFERA (HYMENOPTERA: APIDAE) AND TRIBULUS CISTOIDES (ZYGOPHYLLACEAE)

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In southern Florida a common weed of disturbed areas is *Tribulus cistoides* L. (Burr Nut or Puncture Vine). A frequent visitor to this plant is the Honey Bee, *Apis mellifera* L. Little is known about the reproductive biology of this weedy plant (Porter, 1971; pers. comm.), but observations in Florida suggest some interesting interactions between *Apis* and *Tribulus*.

According to Grant (1950) there is a division of labor among field bees of *Apis mellifera*. Some of the workers carry water; others gather pollen, nectar or propolis, while others search for new food sources. The constancy of an individual to her job and to a particular plant species has been amply verified by numerous authors and summarized by Grant (op. cit.).

While I have observed Hemiptera, Lepidoptera, Diptera, and other Hymenoptera on *Tribulus* in Florida, the most frequent visitors observed on the plants near Boca Raton, Palm Beach County, are *Apis mellifera*. There is a marked behavioral division among the Honey Bee individuals visiting the plants.

Most of the Honey Bees visiting the flowers approach in the "normal" bee fashion described by Meeuse (1961) and Fagri & Pijl (1966). Instead of landing on the stamens and stigmas as they should, however, they circle around the flower and land on the outside of the calyx and corolla (Figs. 1-4). After landing they separate two petals with their front legs, insert their tongues, and sip nectar (Fig. 3). They continue this procedure around the flower until they have collected nectar between all the petals. Once a flower has been utilized, the bees fly to another and repeat the process. Several flowers are usually visited before the bee disappears.

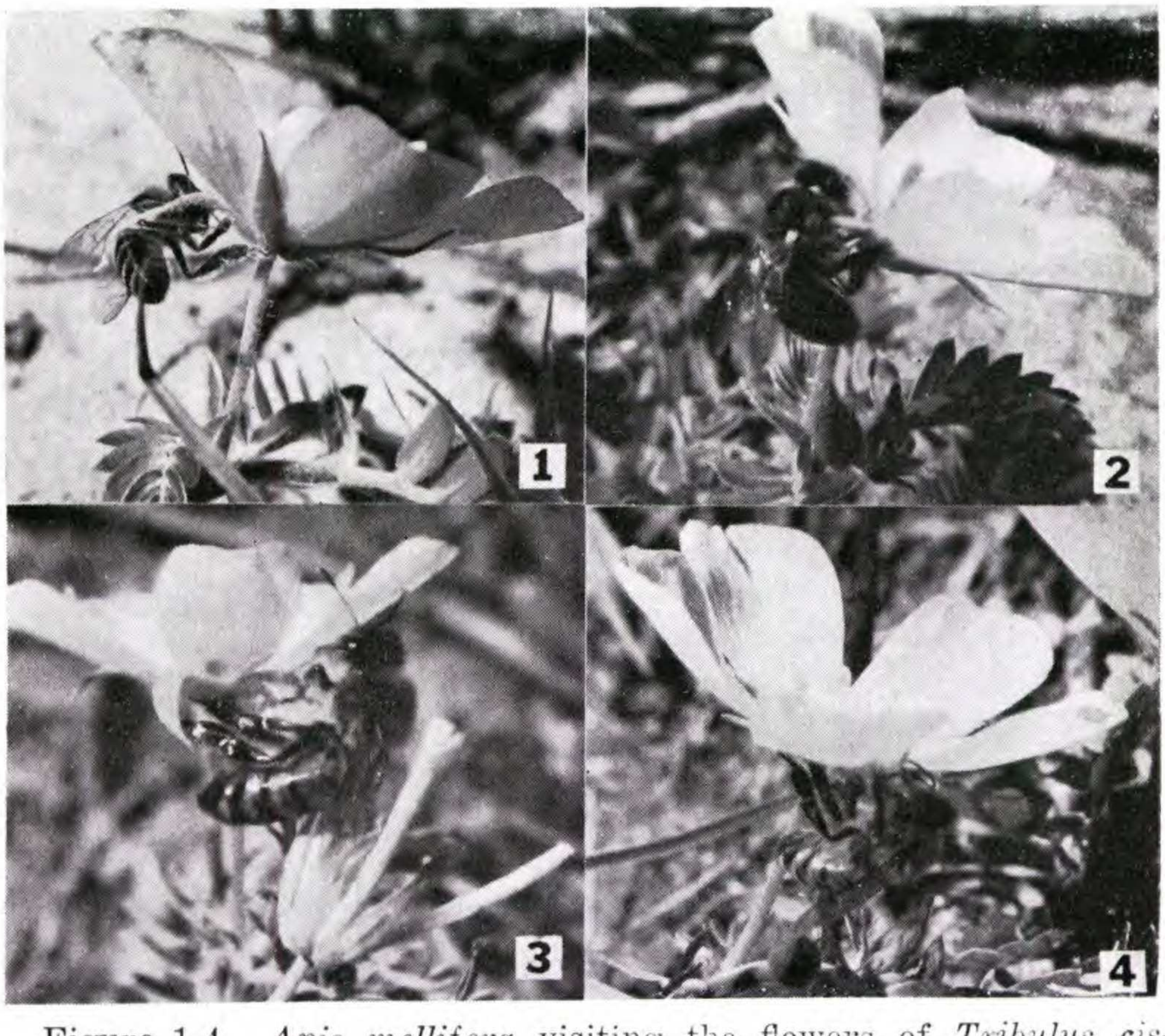

Figure 1-4. *Apis mellifera* visiting the flowers of *Tribulus cistoides* from the back. Note the tongue of the bee in Fig. 3.

Other Honey Bees approach and land within the corolla in the "normal" manner. In so doing they position their bodies over the stigma and stamens (Figs. 5-7). Normally they insert their tongue between the petals and the nectary (Fig. 7), sip nectar, and turn around the flower to drink nectar from other nectaries. They dust much of their body with pollen as they turn (Figs. 5-6). After the nectar has been collected, they often brush the stamens with their front legs to gather pollen.

After nectar has been taken and pollen gathered with the front legs, the bees may fly to another flower to repeat the process. It is common, however, for an individual to brush pollen, fly off and hover in front of the flower, return to brush more pollen, and hover again. This may be done three or four times before the process is repeated at another flower.

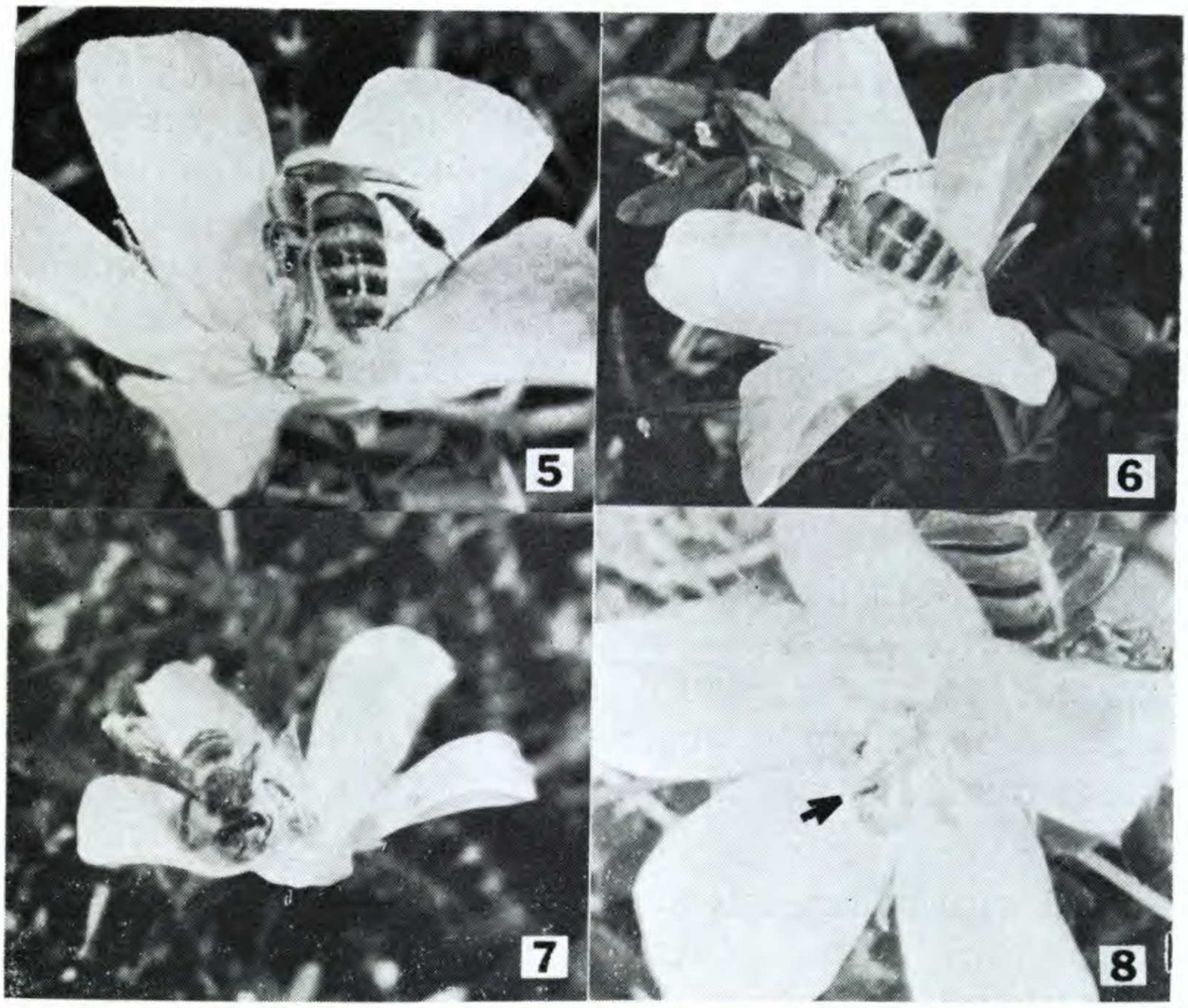

Figure 5-8. Bees visiting the flowers of *Tribulus cistoides* from the front. Fig. 5-7. *Apis mellifera.* Fig. 8. *Chloralictus.*

Those individuals which exhibit this hovering behavior usually have their pollen baskets full. The bees with pollen in the pollen baskets have little or no pollen adhering to the hairs of their legs and body. Bees which have no pollen in their baskets rarely hover, and their bodies and legs usually are dusted with pollen. The individuals illustrated here (Figs. 5-7) were photographed between 3:40 and 4:40 p.m. in December. Although their bodies are dusted with pollen, the pollen baskets are empty.

There has been a seasonal shift in the labor of the individuals visiting the plants. From September until December about 18 out of 20 Honey Bees gathered nectar. None of the nectar gathering bees were ever seen collecting pollen. In February the visitation had dropped from about 20 bees to about 4 bees per hour. All of those bees seen in February were gathering pollen.

Associated with the reduction of visits by Honey Bees was an increase of visits by other insects. During February the flowers were visited by five bee species, three Diptera, one Hemiptera, and one Lepidoptera in addition to the Honey Bees. Equivalent observations in December revealed visits by Honey Bees with one other bee species (*Chloralictus* — Fig. 8), two Diptera, and one Lepidoptera. Honey Bees were most common in December; other bees (*Agapostemon*, *Chloralictus* (2 species), *Halictus*, and *Lasioglossum*) in February.

The reason for the apparent preference for *Tribulus* nectar over pollen during the period from September to December is not clear. Nor is it clear that these observations are the result of a rigid division of labor. There must be some strong force (attractant?) which guides the Honey Bees around the visual guides usually followed in flowers.

Since much of the underside of some Honey Bees is dusted with pollen, self- or cross-pollination could easily be accomplished. The plants have not been tested for autogamy or self-compatibility, but the ample fruits present suggest that Honey Bees or other visitors may successfully complete pollination. Porter (pers. comm.) indicates that *T. cistoides* is protandrous and thus probably outcrossing. Self-compatibility, however, should not be ruled out until demonstrated.

Tribulus cistoides is native to tropical and subtropical Africa (north to Cape Verde on the west and Mozambique on the east). Since it is now widely dispersed throughout the drier tropics, it often becomes a bothersome weed. *Apis mellifera*, probably native to the Mediterranean area, is also naturalized in the New World. The interactions between *Apis* and *Tribulus* in Florida probably did not evolve as the result of foraging activities of the Honey Bee in the Old World since 1) *Apis* is polytropic by nature, and 2) their distributions do not permit a long history of coevolution. It must have been only recently that *Apis* learned to utilize *Tribulus* as a nectar and pollen source, especially since *Apis* is capable of rapid learning (Meeuse, 1961;

Adams, pers. comm., 1971). Regardless of where and when *Apis* learned, pollen is frequently transported from one *Tribulus* flower to the other by the visits of *Apis*.

An important factor in the reproduction of the plants is the approach used by the *Apis* individuals. Those bees approaching from the back of the flowers merely "steal" nectar without transferring pollen, while those workers entering the flowers from the front effect pollination.

The majority of species other than *Apis* visit the flowers of *Tribulus* in the "normal" front approach. Deviations from this are the one Lepidoptera (*Melachroia*) which took nectar from the back of the flower, and occasional individuals of the Dance Fly (Diptera: Empididae) species. Most of the Dance Flies utilized the flowers in the normally expected front approach. The flies are too small, however, to accomplish much pollination.

The largest visitor observed on the flowers was a Diptera, probably a Syrphid fly, but no collection was made. Several flowers were visited by the fly before attempts at photography frightened it away. Another fly, a Tachinid Fly, has been seen occasionally throughout the period of observation. This species is commonly prey to yellow predatory spiders in the flowers.

Hymenoptera other than *Apis* have been seen on the flowers. One, a small *Chloralictus* bee, crawled under the stamens and stigma (Fig. 8). Although the individual in the photograph was not captured, others with the same behavior have been collected. These small insects moved among the stamens as they went from nectary to nectary. Due to the visits among the stamen their bodies often became heavily dusted with pollen (Fig. 8). In spite of this none of them has been seen in contact with the stigma; pollination by these small bees must be rare. An Ash-Gray Leaf Bug (Hemiptera: Piesmatidae) exhibited much the same behavior as the small *Chloralictus* bee.

Four bee species other than *Apis* are probably effective in the pollination of *Tribulus*. *Agapostemon*, *Chloralictus nymphaerum*, *Halictus*, and *Lasioglossum* all collect pollen

and nectar in the "normal" manner, and the undersides of their bodies are heavily dusted with pollen. A fifth species was observed on the plants, but not captured. This large wasp-like Hymenoptera visited the plants near Boynton Beach and gathered only nectar on the single visit observed.

PLANT COLLECTIONS: FLORIDA: PALM BEACH COUNTY: hammock end north of public beach in Boynton Beach, *Austin* 4395 (FAU); campus of Florida Atlantic University, *Austin* 4422 (FAU, MO).

INSECT COLLECTIONS: HEMIPTERA: PIESMATIDAE: *Austin* 4422-15, 4422-16 (FAU). LEPIDOPTERA: GEOMETRIDAE: *Melanchroia cephise* (Cramer), *Austin* 4422-24 (FAU). DIPTERA: EMPIDIDAE: *Austin* 4422-13, 4422-14 (FAU); TACHINIDAE: *Austin* 4422-27 (FAU). HYMENOPTERA: APIDAE: *Apis mellifera L.*, *Austin* 4422-1, 4422-2, 4422-3, 4422-17, 4422-18, 4422-19, 4422-20 (FAU); HALICTIDAE: *Agapostemon splendens* Lef.. *Austin* 4422-21 (FAU); *Chloralictus nymphaerum* Robertson, *Austin* 4422-5, 4422-23 (FAU); *Chloralictus* aff. *marinus* Crawf., *Austin* 4422-26 (FAU); *Halictus* sp., *Austin* 4422-4, 4422-28 (FAU); *Lasioglossum* sp., *Austin* 4422-6, 4422-23 (FAU).

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